IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT APPLICATION

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INVENTION TITLE: RADIANT LIGHT COLLECTION AND DISTRIBUTION FROM SEGMENTED REFLECTOR SYSTEMS AND COMBINED REFLECTOR AND REFRACTOR SYSTEMS

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Sir:

Your applicant, named above, hereby petitions for grant of a utility patent to him or any assignee of record, at the time of issuance, for an invention more particularly described in the following specification and claims with the accompanying drawings, verified by the accompanying declaration and entitled:

RADIANT LIGHT COLLECTION AND DISTRIBUTION FROM SEGMENTED REFLECTOR SYSTEMS AND COMBINED REFLECTOR AND REFRACTOR SYSTEMS

Cross-Reference To Related Applications

[0001] This application is related to and claims the benefit of Provisional Application Serial No. 60/390,237 filed June 20, 2002, the content of which is hereby included herein by reference.

Field of Invention

[0002] The present invention relates generally to the lighting field, and, more particularly, to creating fixtures that provide broad, evenly distributed illumination from quasi point source lamps.

Summary of Invention

[0003] It is an object of the present invention to provide efficient highly directable light for broad evenly distributed illumination over various architectural surfaces.

[0004] It is another object of the present invention to provide sharp light cutoff from the luminaire as to decrease glare.

[0005] It is yet another object of the present invention to shape surface illumination patterns.

[0006] It is yet a further object of the present invention to project a majority of the flux provided by a quasi point source lamp in a unified direction.

[0007] It is yet another object of the present invention to produce a compact optical system to reduce luminaire depth.

[0008] These and other objects of the present invention are accomplished as described below

[0009] A quasi point source located on an optical axis having a radially segmented reflecting disk substantially parabolic or ellipsoidal in section the focal point of which is disposed along the optical axis and corresponding to the quasi point source. The radiating disk of light radiating from the segmented reflector disk is sectionally perpendicular on an obtuse angle to the optical axis and is segmented into individual collimated beams as reflected off transverse concave surfaces on the radial sections.

[0010] Further surrounding the quasi point source is a segmented reflector ring which is substantially concentric to the segmented reflector disk and is positioned along the optical axis as to receive the reflected beams from the segments of the reflector disk and also direct light from the quasi point source. The segments

of the reflector ring are disposed in a manner to alternately reflect beams from the reflector disk and rays from the quasi point source and are tilted in respect to the optical axis so as to direct both the individual beams and the direct rays substantially towards the same area to be illuminated.

[0011] These and other objects, features and advantages will be apparent from the following detailed description of preferred embodiments taken in conjunction with the accompanying drawings in which:

Brief Description of Drawings

[0012] **Figure** 1 is a cross-sectional, three dimensional diagram of an optical system designed to collect and distribute light in a broad even pattern.

[0013] **Figure** 1A is a sectional diagram illustrating the cross-sectional view of reflector disc RD in figures 1, 2, 3, 4, 5, and 6.

[0014] **Figure** 2 is a plan view of figure 1.

[0015] **Figure** 3 is a diagram that further illustrates the function of a portion of the reflector system that is illustrated in figure 1.

[0016] **Figure 4** is a three-dimensional view of a luminaire similar to that described in figures 1 and 1A.

[0017] **Figure 4B** is a three-dimensional diagram that illustrates an alternative component to that shown in figure 1.

[0018] **Figure 5** is a cross-sectional diagram of a luminaire having similar reflective structures as in figures 1, 2, 1A, 3, and 4 with the addition of a lens component.

[0019] **Figure 6** is a cross-sectional diagram of an optical system similar to that of figure 4 with the addition of a ring lens component.

[0020] **Figure 7** illustrates a variation to the optical system of figure 6 with a segmentation of the ring lens component.

[0021] **Figure 8** is a three-dimensional diagram of a variation to the lens illustrated in figure 6.

[0022] **Figure 8A** is a plan view of figure 8.

Detailed Description of the Drawings

[0023] **Figure 1** is a cross-sectional, three-dimensional diagram of an optical system designed to collect and distribute light

in a broad even pattern. The system provides light in a direction as reflected, and through an area which will be referred to as an aperture. The optical system represented is composed of a central lamp L having a quasi point source QP, which can be a filament or arc. A reflector disk RD is disposed along light axis AX. RD is radially segmented into pie-shaped segments RDP. The number of RDP segments may vary and may be unequal in respect to the central angle of RD. RD has a compound surface, the radial section of which (represented by dotted line RP) is substantially parabolic; the focal point of the parabola aligns substantially at QP. The transverse section of RDP is concave (represented by dotted line CP), the acuteness of concavity increasing as the transverse section of RDP increases as the distance increases from AX. This is explained further in connection with Fig. 3. The resulting compound surface of RDP results in beam CB, which is focused onto a segment, ISR, of reflecting ring RR.

[0024] Reflecting ring RR is substantially concentric to RD, having AX as its axis. RR is comprised of alternate reflector segments DSR and ISR. ISR receives and redirects CB (which is focused onto ISR) as beam RB1. RB1 is a representation of a conical

beam that would results from having multiple reflector segments ISR. Reflector segments DSR has a concave cross-section (represented by dotted line SR), that collects and projects radiant light RC1 from QP as beam RB2. Since ISR and DSR are canted at different angles in relation to AX, the central beam angle of A1 of RB1 and A2 of RB2 are substantially equal. RB2 represents one of the multiple reflected beams emanating from multiple reflecting segments of DSR.

[0025] The conical beams of RB1 and RB2 form a substantially homogenous conical beam.

[0026] **Figure 1A** is a sectional diagram illustrating the cross-sectional view of reflector disk RD in Figs. 1, 2, 3, 4, 5, and 6. The central axis AP of the parabola PRS may be rotated around the focal point FP, increasing or decreasing angle RA in respect to the center of radiation AL of L, therefore changing the cant of the conical beam RB. RA may be 0°.

[0027] **Figure 2** is a plan view of Fig. 1, illustrating rays CB reflected from a common reflector segment RDP onto a reflector segment ISR of RR; direct rays RC1 (radiating from lamp L) onto a

reflector segment DSR of RR; and direct rays RC2 (radiating from lamp L) onto a reflector segment DSX of RR. DSR is comprised of cylindrically concave surfaces DSU, which reflect RC1 as converging then diverging rays RC1C. DSR2 is comprised of cylindrically convex surfaces DSX, which reflect RC2 as diverging rays RC2X.

[0028] **Figure 3** is a diagram that further illustrates the function of a single RDP segment of reflector disk (RD of Figure 1). The radial axis RA of RDP is substantially parabolic, controlling the vertical height of light target area TA. The radius of the transverse curvature of RDP decreases as the distance from QP of lamp L increases; the radius of C1 is greater than the radius C2. And therefore, the focal distance of reflected beam RC1 is longer than the focal distance of reflected beam RC2. As the radius of the transverse curvature decreases, the focal distance of the curvature decreases. Thus, the width of TA is maintained and relatively uniform.

[0029] **Figure 4** is a three-dimensional view of a luminaire similar to that of the luminare described in Figs. 1 and 1A, with the following variations in components: RD is parabolic in cross-section (represented by dotted line RDS), but not radially segmented, and a

ring of vertically-oriented cylindrical lenses RCL surround lamp L containing quasi-point source QP. RD reflects and projects radiation from QP onto RR as a canted conical beam PRR. RCL divides radiation from QP forming radial bands of radiation CPR, which are reflected and vertically condensed as rays RR2 by reflector segments RRC of RR. PRR is reflected from reflector segments RRP as rays RR1. CPR and RRP segments are at different angles to each other (represented respectively by angles AR2 and AR1) in respect to lamp axis AX so that RR1 and RR2 may be targeted toward the same area.

[0030] **Figure 4B** is a three-dimensional cross-sectional diagram that illustrates an alternative to segmenting reflector disk RD (in Fig. 1) in order to create segmented radial beams CB (in Fig. 1).

[0031] L is surrounded by substantially vertically or curved cylindrically segmented ring PCL, which divides radiation from L into radial beams SPR, which are further reflected by RD as beams SRR (shaped as RD in Fig. 4) onto ISR (as in Fig. 1).

[0032] **Figure 5** is a cross-sectional diagram of a luminaire having similar reflective optical structure, as illustrated in Figs. 1, 2,

1A, and 3 or Fig. 4, as represented by reflectors RDPISR and DSR surrounding lamp L with the addition of lower lens LL. LL is shaped to allow reflected rays RR1 and RR2 to pass through at angles that are not highly acute (less than 20°) so as to not cause reflection of the beam R1 and therefore decrease the efficiency of beam RR1. The same applies to direct radiation DR from L.

[0033] **Figure 6** is a cross-sectional diagram of an optical system comprised of RD and RRP of Fig. 4, with the addition of canted collimating ring lens RL, which gathers radiation from L and projects it as conical beam CPB, the section of which is parallel on at an acute angle to the section of reflected conical beam RB1.

[0034] **Figure 7** illustrates a variation of the optical system of Figure 6, showing ring lens LRP surrounding L, which is segmented into individual lenses that gather radiant light from L and project beams CB.

[0035] LRP may be single or double convex lenses, meniscus lenses, fresnel lenses, or lenses that are formed by adding cylindrical surfaces onto the inside or outside of ring collimators. When part of a ring, these lenses (LRP) may occupy the entire ring or be spaces forming alternate areas on the ring that perform other

optical functions. This is further illustrated in Figs. 8 and 8A by combining reflector optics shown in Figs. 1, 1A, 2, 3, 4, 4B, 5, 6, and 7, with the refracting optics in Figs. 7, 8, and 8A substantially square or rectangular, so that patterns of light can be achieved.

[0036] **Figure 8** is a three-dimensional diagram of a conical ring lens CRL having convex surfaces CX alternating with areas of inner and outer concentricity CV that have no lensing power. CX projects radially collimated beams CB while CC allows light RD to leave on the radius of the light source (not shown). Power may be given to the outside surface OCS, which would control the degree of collimation in respect to the central axis AX of CRL.

[0037] **Figure 8A** is a plan view of a lens illustrated in Fig. 8, showing varied surfaces that may be alternated with the inner or outer surface of the lens CX, which is cylindrically convex projecting either converging then diverging beam CD or a collimated beam. CV is cylindrically concave, forming a diverging beam DV. CF is flat, forming a beam PC that is more acute radial rays direct from the light source QP, surface M having no power (the inner and outer surfaces of the ring being concentric) allowing rays from QP to leave on the radii of radiation.

[0038] It will now be apparent to those skilled in the art that other embodiments, improvements, details, and uses can be made consistent with the letter and spirit of the foregoing disclosure and within the scope of this patent, which is limited only by the following claims, construed in accordance with the patent law, including the doctrine of equivalents.